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DOBUTAMINE, A BETA AGONIST, REDUCES MUSCLE AND BONE LOSS IN DENERVATED HINDLIMBS. M.L. Walker, K. Prater, R. Herz, S. Whittenberger and B. Girten*. Wright State University School of Medicine, Dayton, OH 45435.

INTRODUCTION. Hindlimb denervation produces alterations in skeletal muscle and bone similar to those observed in animals exposed to microgravity. The objective of this experiment was to determine if dobutamine (DOB), a synthetic catecholamine and a beta agonist, could effectively attenuate bone and muscle changes induced by 12 days of hindlimb denervation. METHODS. Adult male Sprague-Dawley rats (n=14) underwent unilateral sciatic nerve transection on the right hindlimb. After surgery rats were randomly assigned to either control saline (SAL) or DOB treatment groups. Each animal received two intraperitoneal injections per day, given approximately one hour apart, for 11 of the 12 days. Bone mineral content (BMC) of the proximal head (PH) and shaft (PS) of the tibia from both the innervated (INNERV) and denervated (DENERV) hindlimbs of each rat were measured by a bone densitometer (SP-2 Lunar). Muscle weights of the soleus (SOL) and plantaris (PLT), and citrate synthase (CS) enzyme levels of the SOL muscle were examined. RESULTS. ANOVA and Tukey's post hoc tests ($p<0.05$) indicated a significant reduction in wet weight of the SOL and PLT muscles in the DENERV SAL group when compared with their INNERV hindlimb counterparts. BMC of the PH and PS of the tibia and CS levels of the SOL were also significantly reduced in the DENERV animals that received SAL. Although animals which received DOB treatment did have decreases in muscle mass, BMC and CS in the DENERV hindlimb, these decreases were not significant when tested against their INNERV values. DOB treatment appeared to be most effective in bone, where the decrease in BMC produced by DENERV in SAL animals was almost entirely eliminated in rats receiving the drug. CONCLUSION. These data indicate that DOB is able to effectively attenuate alterations in muscle and bone which are induced by hindlimb denervation. This information suggests that DOB may be effective as a countermeasure for some of the deconditioning like changes which result from exposure to a microgravity environment.

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CHANGES IN LEFT VENTRICULAR FUNCTION AS DETERMINED BY THE MULTI-WIRE GAMMA CAMERA AT NEAR PRE-SYNCOPAL LEVELS OF LOWER BODY NEGATIVE PRESSURE. **+R. Pinter, *S. Fortney, **S. Mulvagh, #J. Lacy. +KRUG Life Sciences, *NASA Johnson Space Center, **Universities Space Research Association and #Baylor College of Medicine.**

At presyncopal levels of lower body negative pressure (LBNP), we have frequently observed electrocardiographic responses that may be due to changes in cardiac position and/or shape, but could be indicative of altered myocardial function. To further investigate this, we evaluated cardiac function using a nuclear imaging technique in 21 healthy subjects (17 men and 4 women) after 30 minutes of supine rest and near the end of a presyncopal-limited LBNP exposure (LBNP averaged 65 ± 3 mmHg at injection). Cardiac first pass images were obtained using a Multi-Wire Gamma Camera following an intravenous bolus injection of 30-50 millicurries of ^{178}Tantalum. Manual blood pressures and electrocardiograms were obtained throughout the 3-minute graded LBNP protocol. Between rest and injection during LBNP, heart rate increased ($P<001$) from 67 ± 3 bpm to 99 ± bpm, systolic blood pressure decreased ($P<0.01$) from 119 ± 3 mm Hg to 107 ± 3 mm Hg and left ventricular ejection fraction (EF) decreased ($P<0.01$) from 0.57 ± 0.02 to 0.48 ± 0.02. During LBNP, ST segment depression of at least 0.5 mm occurred in 7 subjects. Subjects with ST segment depression had greater reductions ($P = 0.05$) in EF than subjects without ST depression (0.15 ± 0.07 vs. 0.05 ± 0.03), but also tolerated greater levels ($P<0.05$) of negative pressure (88 ± mm Hg vs. 69 ± 5 mm Hg). There was a significant relationship between presyncopal LBNP level and EF ($R^2 = 0.50$, $P< 0.05$). Our findings suggest there may be a decrease in systolic myocardial function at high levels of LBNP.

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EFFECT OF LBNP ON CEREBRAL CIRCULATION

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INTRODUCTION The purpose of our study is to determine the effects of lower body negative pressure(LBNP) on cerebral circulation. **METHODS** Oxygenation and hemodynamics of the brain were measured continuously and noninvasively in eight cases who were exposed to 30mmHg LBNP for 25min by using a carotid doppler, a transcranial doppler, a cutaneous laser doppler, and a near infrared spectrophotometry. **RESULTS** The carotid blood flow and the mean velocity of the middle cerebral artery decreased in almost every cases, even though the systemic blood pressures were well maintained. Oxygenated hemoglobin and cerebral blood volume of the brain typically increased while deoxygenated hemoglobin showed variable small changes. **CONCLUSION** The results of the carotid doppler and the transcranial doppler indicate that the cerebral blood flow might decrease during LBNP. From the increase of oxygenated hemoglobin and cerebral blood volume, it is suggested that the dilatation of the cerebral vessels occur at the arterial side. Taken together, it can be said that exposure to moderate LBNP typically produces a decrease of the cerebral blood flow with a compensatory vasodilatation of the arterial side of the brain.

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EAR OPACITY SHOWS HEAD-LEVEL BLOOD FLOW CYCLING DURING STEADY-STATE EXPOSURE TO +Gz. F. Buick* and J. Maloan. Defence and Civil Institute of Environmental Medicine, North York, Canada, M3M 3B9.

INTRODUCTION. The generally accepted +Gz time/tolerance curve (Stoll, 1951) shows a smooth and horizontal band through discrete points of tolerance up to 20 sec after the "trough". While this suggests cardiovascular steady-state, head-level blood flow, and arterial pressure at heart and head level are known to increase and decrease with regular frequency (Wood and Lambert, 1989). If so, +Gz tolerance capacity may vary during this time. METHODS. Continuous head-level perfusion indices were obtained from measurement of ear opacity, a technique developed in the Mayo Centrifuge Laboratory in the '40s. 7 relaxed subjects were exposed to 1 +Gz/s onset rate centrifuge profiles with 2 min of sustained +Gz. +Gz level increased in successive 0.5 +Gz increments beginning at +2.5 Gz until visual blackout. RESULTS. In the first 5 s of +Gz exposure, ear opacity and ear opacity pulse amplitude decreased. The decrease was more marked at increased +Gz levels. Cardiovascular compensation occurred over the next 5 s which increased opacity and opacity pulse. For the remainder of the 2 min exposure, ear opacity and ear opacity pulse increased and decreased with a mean cycling period of 10.4 s. The mean difference in the opacity levels within cycles was 17.1% of the +1 Gz opacity value. CONCLUSIONS. These results suggest head-level perfusion is not constant during the supposed cardiovascular steady-state period of sustained +Gz exposure. It follows that the physiological ability to avoid loss of consciousness may also fluctuate.

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ASSESSMENT OF CEREBRAL BLOOD FLOW BY TRANSCRANIAL DOPPLER METHOD DURING +Gz ACCELERATION IN HUMAN. G. OSSARD, J.M. CLERE*, F. MELCHIOR, A. RONCIN, J. SEYLAZ. Laboratoire de Médecine Aérospatiale, Centre d'Essais en Vol, F91228 Brétigny sur Orge Cedex; France.

INTRODUCTION. Limit of human tolerance to $+G_z$ acceleration is attributed to cerebral perfusion failure. A study using transcranial Doppler (TCD) was conducted in order to evaluate changes in cerebral blood flow (CBF) under $+G_z$ stress. METHOD. 9 relaxed volunteers were exposed to 30 sec $+G_z$ plateaus of 2, 3, 4 and 5 G (G-onset rate=1G/s). CBF changes were assessed by transcranial Doppler recording of middle cerebral artery (MCA) blood flow velocity. Arterial pressure (heart level) was monitored with a continuous non-invasive method (Finapres 2300). From these data, mean cerebral artery perfusion pressure was computed. RESULTS. Mean blood flow velocity (MBFV) was significantly decreased during G-onset and during 2 and 4 $+G_z$ plateaus. MBFV ± S.E.M. decreased from 11.5 ± 5.2 % (2 $+G_z$) to 44.5 ± 24.% (5 $+G_z$). Three main intolerance cases were observed correlated with transient or extended blood flowing back in MCA. DISCUSSION. The sensitivity of TCD method is adequate to evaluate small variations of CBF at 2 +Gz. The method shows that CBF is insufficient at certain 5 +Gz profiles, explaining intolerance symptoms.

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HEMODYNAMIC RESPONSES OF THE SWINE TO G-SUIT INFLATION, THE AGSM AND PRESSURE BREATHING DURING +Gz (PBG). JW Burns*, JW Fanton and JL Desmond. Crew Technology and Veterinary Sciences Divisions, Armstrong Laboratory, Brooks AFB, TX 78235-5000.

INTRODUCTION The G-protective benefits of PBG have been well demonstrated. A swine model has been developed to investigate the physiologic bases for these benefits. METHODS A mask and a chest counterpressure garment have been fabricated for application of PBG to the swine. G-suit protection was supplied by an extended coverage suit which provided nearly complete body coverage caudal to the rib cage. Left and right ventricular pressure, left and right ventricular stroke volume (SV) and cardiac output (CO), aortic pressure, eye-level blood pressure (ELBP), heart rate (HR), central venous pressure, esophageal pressure, mask pressure, and G-suit pressure were measured during +Gz with and without PB and during PB without +Gz. RESULTS During a 130 sec exposure to a 5-9 +Gz SACM mean ELBP was maintained above 55 mmHg without PBG and above 70 mmHg with PBG by an increase in total peripheral resistance, even though SV, CO and HR decreased by 57%, 63% and 5%, respectively, without PBG and by 45%, 60% and 2%, respectively, with PBG. The combination of G-suit inflation, the AGSM and PB during +Gz resulted in significantly increased intravascular pressures. However, a similar increase in intrathoracic pressure resulted in minimal transmural vascular pressure changes. CONCLUSIONS Elevated ELBP with PBG compared to without PBG supports the finding in man of extended time at +Gz and a reduction in the physical effort to maintain vision during sustained +Gz.